

[Name of Document] Specification

[Title of the Invention]

SYSTEM AND METHOD FOR PROCESSING A SUBSTRATE AND PROGRAM  
THEREFOR

5 [Technical field]

The present invention relates to a system and method for performing a predetermined process on a substrate by controlling multiple component devices of a substrate processing apparatus, and a program to carry out the method.

10 [Prior Art]

Conventionally, a magnetron parallel plate type substrate processing apparatus shown in Fig. 10 is known as a substrate processing apparatus for processing a semiconductor wafer W as a substrate.

15 This magnetron parallel plate type substrate processing apparatus 500 has a cylindrical processing-chamber vessel 501, which has an upper electrode 513 disposed at a top portion thereof and a cylindrical lower electrode 504 disposed at a lower portion thereof. For  
20 clamping a semiconductor wafer W, an ESC (electrostatic chuck) 502, which is surrounded by a focus ring 503 is mounted on the lower electrode 504. An isolation plate 507 is disposed adjacent to a top portion of the lower electrode 504 to separate the interior of the processing-chamber  
25 vessel 501 into a processing region 505 and a gas exhaust region 506. A gas exhaust port 508 is disposed at the lower

portion of the processing-chamber vessel 501 to evacuate the processing region 505 under negative pressure through the gas exhaust region 506. Further, a loading/unloading opening 509 for the semiconductor wafer W is disposed on a wall facing the processing region 505.

Further, while the upper electrode 513 is grounded, the lower electrode 504 is connected to at least one high frequency power supply 511 via a matching circuit 510, and an annular permanent magnet 512 is disposed around an upper part of the processing-chamber vessel 501.

Regarding the substrate processing apparatus 500, the processing region 505, into which a processing gas is introduced through gas outlet holes disposed in the upper electrode 513, is controlled to a predetermined pressure level through negative pressure evacuation. Further, the high frequency power supply 511 excites a high frequency electric field in the processing region 505 located between the upper electrode 513 and the lower electrode 504 while the permanent magnet 512 generates a parallel magnetic field perpendicular to the high frequency electric field. A high density plasma is generated from the processing gas by the high frequency electric field and the parallel magnetic field perpendicular thereto, and the plasma performs a desired processing on the semiconductor wafer W.

In the substrate processing apparatus 500, maintenance of expendable parts such as the focus ring 503 is important;

and in order to reduce the number of steps required for programming a maintenance program that conducts an operation test, which is one of the confirmation items during maintenance, a method that pre-registers the operation of components such as the focus ring 503, whereby each registered operation is combined at will to set up sequential and/or parallel operations thereof to write a maintenance macro file, has been known (e.g., see Patent Publication 1).

10           Meanwhile, in the substrate processing apparatus 500, a process executing unit (not shown), which has a CPU and other components that are installed in pertinent substrate the processing apparatus 500, executes a loading/unloading sequence of the semiconductor wafer W or an execution control sequence of a recipe, i.e., an individual processing program of the substrate processing apparatus, on control parameters (control target values of temperature, pressure, gas type and flow rate, time and the like) for the substrate processing (process) by way of operating various devices  
15           such as the above-described upper electrode 513 based on a program generated from compiled source codes that express sequences of various processes in a predetermined programming language. Recently, however, since a precise reproducibility is required in a process as etching patterns  
20           of a semiconductor wafer W are getting finer, parameter items need to be prescribed in further detail while an

execution of a recipe appropriate for an individual substrate processing apparatus is necessary.

As a result, since recipes for a process should be customized to the substrate processing apparatus 500, although process experiments need to be conducted repeatedly with respect to the substrate processing apparatus 500, parameter items, however, are prescribed in the pertinent recipes in further detail as mentioned above, so that continual updating of the change in contents of the sequences including the executed recipes results from the increase of the kinds of recipes to be executed in the process experiments. Further, the changes in the content of the sequences refer to changes in the order of device operations, contents of the operations, waiting time, and the like.

Moreover, with respect to a source code, in addition to the execution control sequence of recipes as previously mentioned, a sequence of an interlock process about the operation of the substrate processing apparatus 500 and a sequence of a recovery process related to the interlock process are described.

By the sequences of the interlock and the recovery process, the operation of each device of the substrate processing apparatus 500 is controlled based on a predetermined condition when the sequence of the loading/unloading of a semiconductor wafer W or the

execution control sequence of the recipe is executed; and, further, for example, an alarm is activated to warn the user when the operation of each device based on the predetermined condition is controlled. In addition, accompanying the frequent changes in the contents of sequences including the recipes recently executed, content changes of the sequence of an interlock and recovery process concerning the interlock are frequently made as well.

Further, the substrate processing apparatus such as a magnetron parallel plate type substrate processing apparatus is usually placed in a clean room in order to prevent contaminants from sticking to a semiconductor wafer W. The substrate processing apparatus has an operation panel, which displays a list made of multiple operation items. Further, the user needs to go to the clean room, when controlling the substrate processing apparatus, in order to select a desired operation item from the list on the operation panel for operating the apparatus. Therefore, the user can operate the substrate processing apparatus while watching it on the spot.

However, since cases exist where the user need not observe firsthand the substrate processing apparatus depending on the content of operations, for example, releasing a stoppage caused by a minor trouble. It is undesirable for the user to go to the clean room for such a type of operation from the perspective of an operation

efficiency. Therefore, a substrate processing system capable of remote-controlling the substrate processing apparatus from a remote location such as an office, without a need for the user to be present in the clean room, has  
5 been proposed (hereinafter referred to as a "remote control system").

As such a remote control system, a substrate processing system including a substrate processing apparatus and a remote terminal provided at a place away from the  
10 substrate processing apparatus is well known in the art. The remote terminal has a display device and software for displaying contents similar to those displayed by the operation panel on the display device. Specifically, an industrial apparatus management system, as shown in Fig. 11,  
15 which includes a factory 700, a vendor 800 located at a place remote from the factory 700 and a data communication network 900 for connecting the factory 700 and the vendor 800 is known in the art (for example, Patent Publication 2).

With respect to the management system, the factory 700  
20 has an industrial apparatus 710, a management apparatus 720 for managing the industrial apparatus, and a factory-side controller 730 for controlling the industrial apparatus 710 through the management apparatus 720 while the vendor 800 has a vendor-side controller 810.

25 The management apparatus 720 has a management program 722 for controlling the management system; the factory-side

controller 730 has a control program for controlling the controller's operation; and the vendor-side controller 810 has a control program 813 for controlling the operation thereof.

5           The management program 722 assigns an authority for the operation of the industrial apparatus 710 to either the factory-side controller 730 or the vendor-side controller 810. When the authority is assigned to the vendor-side controller 810, the vendor-side controller 810 can remotely  
10 control the industrial apparatus 710 through the management apparatus 720. Accordingly, the vendor 800 can optimize parameters of the industrial apparatus 710, and resolve troubling symptoms thereof.

As described above, in the conventional remote control  
15 systems, each of the substrate processing apparatus and the remote terminal has operation control software for controlling the operation of the corresponding apparatus, and the remote control of the substrate processing apparatus is achieved through communications among the softwares.

20           [Patent Publication 1] Japanese Patent Laid-Open Publication No. 2002-43290 (Fig. 3)

          [Patent Publication 2] Japanese Patent Laid-Open Publication No. 2002-163016 (Fig. 1)

[Disclosure of the Invention]

25 [Problems to be Solved by the Invention]

          However, in the invention disclosed in Patent

Publication 1, it is required to rewrite source codes every time the content of the sequence is changed, which is difficult for a person other than a software engineer to carry out. Further, after rewriting the source codes, 5 executable software needs to be created in order to execute the sequence, by linking programs that are generated by compiling the source codes. Accordingly, a problem exists such that frequent changes of the sequence contents require increased number of works by the software engineer. Further, 10 such changes in the contents the sequence accompany content changes in the sequence of the interlock and the recovery process, which may extensively affect parts other than the element subjected to the change, so that the number of the works of the software engineer is further increased. As a 15 result, the number of processes required for the creation of a program concerning sequences needs to be reduced as in the case of the maintenance program described before.

Further, since there exist two different kinds of operation control software in the remote control system of Patent Publication 2, the number of processes demanded for 20 the creation of the software is considerably large. Moreover, if software of one side is upgraded, the other ones should also be upgraded, thereby creating the problem of expanding the number of processes for managing the 25 software.

It is, therefore, an object of the present invention



to provide a system and method capable of reducing the extensive works performed by a software engineer; and a program for performing the method.

[Means for solving the problems]

5           In order to achieve the above-mentioned object, there is provided a substrate processing system of claim 1 for performing a processing including a plurality of processes on a substrate by operating a multiplicity of devices incorporated in a substrate processing apparatus, which  
10 includes: a storage unit for storing therein commands describing predetermined operations of the devices; a generation unit for generating macro files from the stored commands and creating a process sequence macro by combining the generated macro files, each of the macro files  
15 corresponding to each of the plurality of processes; and an execution unit for executing the process sequence macro.

As described in claim 2, in the substrate processing system of claim 1, the generation unit includes a user interface.

20           As disclosed in claim 3, in the substrate processing system of claim 1 or 2, the commands are converted into hard codes.

As shown in claim 4, the substrate processing system of any one of claims 1 to 3 further includes another storage  
25 unit for storing the generated macro files.

As described in claim 5, in the substrate processing

system of claim 4, said another storage unit is identical to the storage unit.

As claimed in claim 6, the substrate processing system of any one of claims 1 to 5 further includes a communication unit for sending the macro files to an external device and receiving the macro files from the external device.

As described in claim 7, the substrate processing system of claim 6 also includes a verification unit for examining whether the sequence of each of the macro files is normal.

As disclosed in claim 8, in the substrate processing system of any one of claims 1 to 7, the storage unit further stores therein a data file defining a control of a predetermined operation of each of the devices corresponding to the macro files; the generation unit generates the data file; and the execution unit executes the control of the predetermined operation of each of the devices based on the generated data file.

As described in claim 9, in the substrate processing system of claim 8, the storage unit incorporates still another storage unit for storing the data file defining the control of the predetermined operation of each of the devices corresponding to the macro files.

As claimed in claim 10, the substrate processing system of claim 8 or 9, the data file also defines an alarming operation for reporting the completion of the

control of the predetermined operation of each of the devices; and a control of another device related to the predetermined operation of each of the devices.

5 In order to achieve the above-mentioned object, there is provided a substrate processing method of claim 11 for performing a processing including a plurality of processes on a substrate by operating a multiplicity of devices incorporated in a substrate processing apparatus, the method including the steps of: storing commands defining  
10 predetermined operations of the devices; generating macro files from the stored commands and creating a process sequence macro by combining the generated macro files, each of the macro files corresponding to each of the plurality of processes; and executing the process sequence macro.

15 As described in claim 12, in the substrate processing method of claim 11, the storage step further stores a data file defining a control of a predetermined operation of each of the devices corresponding to the macro files; the generation step generates the data file; and the execution  
20 step executes the control of the predetermined operation of each of the devices based on the generated data file.

As disclosed in claim 13, in the substrate processing method of claim 12, the storage step further includes another storage step for storing the data file defining the  
25 control of the predetermined operation of each of the devices corresponding to the macro files.

As claimed in claim 14, in the substrate processing method of claim 12 or 13, the data file also defines an alarming operation for reporting the completion of the control of the predetermined operation of each of the devices; and a control of another device related to the predetermined operation of each of the devices.

In order to achieve the above-mentioned object, there is provided a program of claim 15 for executing a substrate processing method for performing a processing including a plurality of processes on a substrate by operating a multiplicity of devices incorporated in a substrate processing apparatus, wherein the program's operations executed on a computer includes: a storage module for storing therein commands describing predetermined operations of the devices; a generation module for generating macro files from the stored commands and creating a process sequence macro by combining the generated macro files, each of the macro files corresponding to each of the plurality of processes; and an execution module for executing the process sequence macro.

As described in claim 16, in the program of claim 15, the commands are converted into hard codes.

As disclosed in claim 17, in the program of claim 15 or 16, the program also operates another storage module for storing the generated macro files on the computer.

As claimed in claim 18, in the program of any one of

claims 15 to 17, the program further operates a transmission module for sending the macro files to an external device and a reception module for receiving the macro files from the external device on the computer.

5           As described in claim 19, in the program of claim 18, the program further operates a verification module for examining whether a sequence of each of the macro files is normal.

10           As disclosed in claim 20, in the program of any one of claims 15 to 19, the storage module further stores a data file defining a control of a predetermined operation of each of the devices corresponding to the macro files; the generation module generates the data file; and the execution module executes the control of the predetermined operation  
15 of each of the devices based on the generated data file.

          As claimed in claim 21, in the program of claim 20, the storage module incorporates still another storage unit for storing the data file defining the control of the predetermined operation of each of the devices corresponding  
20 to the macro files.

          As described in claim 22, in the program of claim 20 or 21, the data file also defines an alarming operation for reporting the completion of the control of the predetermined operation of each of the devices; and a control of another  
25 device related to the predetermined operation of each of the devices.

There is provided a program of claim 23 for performing a substrate processing method for conducting a predetermined processing on a substrate by using a substrate processing system including a substrate processing apparatus; a  
5 controller equipped with an operation input unit through which an operation of a user is inputted to control an operation of the substrate processing apparatus; and a remote terminal isolated from the substrate processing apparatus and equipped with another operation input unit  
10 through which an operation of a user is inputted, wherein the program's operations executed on a computer includes: an operation control module for controlling an operation of the operation input unit; and another operation control module for controlling an operation of said another operation unit.

15 As described in claim 24, in the program of claim 23, the operation control module includes an input restriction unit for restricting an input of an operation from either one of the operation input unit and said another operation input unit.

20 As disclosed in claim 25, in the program of claim 23 or 24, the operation control module includes an input source determination unit for determining an input source of an operation of the user when the operation is inputted.

There is provided a program of claim 26 for performing  
25 a substrate processing method for conducting a predetermined processing on a substrate by using a substrate processing

system including a substrate processing apparatus; a controller equipped with an operation input unit through which an operation of a user is inputted to control an operation of the substrate processing apparatus; and a  
5 remote terminal isolated from the substrate processing apparatus and equipped with another operation input unit through which an operation of a user is inputted, wherein the program's operations executed on a computer includes: a display module for displaying operation items that can be  
10 inputted to the operation input unit; and a remote input module for displaying the operation items on said another operation input unit and recognizing an input to said another operation input unit as an input to the operation input unit.

15 [Effect of the Invention]

As described thus far in detail, by using the substrate processing system of claim 1, the substrate processing method of claim 11 and the program disclosed in claim 15, commands describing predetermined operations of  
20 devices are stored; macro files are generated from the stored commands, each of the macro files corresponding to each of multiple processes and a process sequence macro is created by a combination of the generated macro files; and the process sequence macro is executed. Therefore, it  
25 becomes possible for the user to change the content of a sequence by changing the content of macro files through the

use of stored commands without a need to rewrite source codes. As a result, the extensive number of works demanded from a software engineer can be reduced. Moreover, frequent changes of contents of a process sequence can be made  
5 without requiring a great number of works from the software engineer as well.

By employing the system disclosed in claim 2, the user can change the content of the macro files readily because a generation unit includes a user interface.

10 By using the substrate processing system disclosed in claim 3 and the program described in claim 16, since the commands are converted into hard codes, compiling and linking works become unnecessary in executing the process sequence macro obtained by combining the macro files. Thus,  
15 the number of works of the user can be greatly reduced.

By using the substrate processing system of claim 4 and the program of claim 17, the user can recycle already generated macro files when changing the content of the sequence because the generated macro files are stored.  
20 Therefore, the number of works of the user can more definitely be reduced.

By using the substrate processing system of claim 5, the configuration of the substrate processing apparatus can be simplified because a storage unit and the other storage  
25 unit are identical.

By using the substrate processing system of claim 6



and the program of claim 18, since the macro files are sent to an external device and received therefrom, the user can carry out a creation of a macro file or change in the content of a macro file by using the external device, so  
5 that the convenience on behalf of the user can be enhanced.

By employing the substrate processing system of claim 7 and the program of claim 19, since whether the sequence of a macro file is normal is examined, occurrences of process error can be prevented in advance when executing the process  
10 sequence macro containing the specific macro file, thereby accompanying an improvement of work efficiency.

By using the substrate processing system of claim 8, the substrate processing method of claim 12 and the program of claim 20, since a data file defining the control of a  
15 predetermined operation of a device corresponding to a macro file is generated and stored, and the control of the predetermined operation of the device is executed based on the data file, the user can change the content of the control of the predetermined operation of the particular  
20 device through the use of the data file without rewriting source codes.

By employing the substrate processing system of claim 10, the substrate processing method of claim 14 and the program of claim 22, since a data file also defines an alarm  
25 operation for reporting a completion of the control of a device's predetermined operation; and the control of another

device related to the predetermined operation of the device,  
the user can change the content of an alarm warning  
corresponding to the control of a predetermined operation of  
a certain device and the content of the control of another  
5 device corresponding to the predetermined operation of the  
certain device through the use of the data file without  
rewriting source codes.

By using the program disclosed in claim 23, since the  
operation input unit's operation is controlled by an  
10 operation control module; and another operation input unit  
is controlled by another operation control module, which  
consists of the same content as the operation control module,  
operations of an operation input unit and another operation  
input unit can be controlled by using the same software.  
15 Accordingly, the number of works that should be performed by  
a software engineer can be reduced and, further, the number  
of processes for creating and managing software for use in  
controlling the substrate processing apparatus and a remote  
terminal can be reduced.

20 By employing the program disclosed in claim 24, since  
an operation input is restricted to either the operation  
input unit or another operation input unit by an input  
control module, duplicative operation inputs from the  
operation input unit and another operation input unit can be  
25 avoided, thereby enabling a smooth control of the substrate  
processing apparatus.

By using the program disclosed in claim 25, by using a input source determination module, since when a user's command is inputted can its input source be determined, an input of an operation requiring a user's firsthand operation  
5 of the substrate processing apparatus from another input operation unit, the safety of substrate processing of the substrate processing system can be improved.

By employing the program disclosed in claim 26, since operation items that can be inputted to the operation input  
10 unit are displayed by a display module; the operation items are shown in another input operation unit by a remote input module; and an input to another operation unit is recognized as an input to the input operation unit, the software for controlling the operation of a remote terminal can be  
15 eliminated, thereby reducing the number of processes for creating and maintaining software for use in controlling the operations of the substrate processing apparatus and the remote terminal.

[Best mode for carrying out the Invention]

20 Substrate processing systems in accordance with embodiments of the present invention will now be described in detail.

Referring to Fig. 1, there is provided a schematic diagram of a substrate processing system in accordance with  
25 a first embodiment of the present invention.

In Fig. 1, the substrate processing system 100

includes a substrate processing apparatus 101 having a configuration identical to that of a conventional magnetron parallel plate type substrate processing apparatus; a substrate processing controller 102 for controlling the substrate processing apparatus 101; and a server (storage unit) 103 for storing therein commands to be described later and data files related to interlocks of the substrate processing apparatus 101; a personal computer (hereinafter refer to as a "PC") 104 (an external apparatus) equipped with an input device such as a keyboard and a mouse, wherein the substrate processing controller 102 is connected to each of the substrate processing apparatus 101, the server 103 and the PC 104 via a wired or wireless network.

The substrate processing controller 102 includes a macro file editor unit 107 (generation unit), which has a RAM 105 serving as a working area for creating macro files to be described later from the commands stored in the server 103, or for editing data files stored in the server 103, and a user interface 106 such as a monitor having a touch panel sensor function; an executor 108 (execution unit) which has a CPU and the like for executing a process sequence macro, to be described later, generated by the combination of the macro files created by the macro file editor unit 107, and for executing the data files; a server communication unit 109 for performing data communications with the server 103 through a TCP/IP or the like; and a PC communication unit

110 for performing data communications through the use of a TCP/IP or the like in the same manner. Further, since the configuration of the substrate processing apparatus 101 is identical to that of the substrate processing apparatus 500,  
5 a detailed explanation thereof will be omitted.

Next, commands stored in the server 103, macro files created from the commands and a process sequence macro obtained by a combination of the macro files will be described.

10 Generally, an etching process of a semiconductor wafer W in a substrate processing apparatus can be divided (profiled) into multiple processes.

Fig. 2 describes an example of dividing the substrate etching process with respect to the substrate processing  
15 apparatus shown in Fig. 1 into multiple processes.

In Fig. 2, the etching process of a semiconductor wafer W is divided into 14 processes including, in the order of performance, a loading preparation process, a loading process, a preparation process, a first stabilization  
20 process, a first maintenance process, a second stabilization process, a second maintenance process, an end point process, a termination process, a first post process, a second post process, an after-treatment process, an unloading process and a static electricity removal process.

25 The loading preparation process is a process for performing a processing between a preparation startup and a

start of loading the semiconductor wafer W; the loading process is a process for loading the semiconductor wafer W into the substrate processing apparatus through the loading/unloading opening to mount it on an ESC; the  
5 preparation process is a process for performing a processing between the point when the semiconductor wafer W is mounted on the ESC and the point when a recipe corresponding to a desired etching processing is started. The first stabilization process is a process for stabilizing a  
10 temperature, a pressure, a gas flow rate and the like so that they are within the ranges, which allow for etching processing to be carried out in the substrate processing apparatus; the first maintenance process is a process for performing the etching processing on the semiconductor wafer  
15 W by maintaining the pressure, the temperature and the gas flow rate within the stabilized substrate processing apparatus. With respect to the second stabilization process, if multiple etching processes are performed, it prepares the second maintenance process and stabilizes a temperature, a  
20 pressure, a gas flow rate and the like so that they are within the ranges, which allow for etching processing to be carried out in the substrate processing apparatus; and the second maintenance process, if multiple etching processes are performed, is a process for performing the etching  
25 processing on the semiconductor wafer W by maintaining the temperature, the pressure, the gas flow rate and the like

within the stabilized substrate processing apparatus. The end point process refers to a process for detecting the end point of the etching processing on the semiconductor wafer W while the termination process is a process for terminating the execution of the recipe. The first post process is a process for evacuating a backside of the semiconductor wafer W in a vacuum while the second post process is a process to change the ESC to an off condition to turn off an electrostatic chuck of the semiconductor wafer W. The after-treatment process is a process for performing a processing after the turning off of the electrostatic chuck until the semiconductor wafer W is unloaded from the substrate processing apparatus. The unloading process refers to a process for unloading the semiconductor wafer W from the substrate processing apparatus while the static electricity removal process represents a process for performing a processing from the start of the static electricity removal of the ESC until the completion of the etching processing.

With respect to macro files, one macro file is set up for each of the 13 processes except for the termination process. Each macro file specifies sequential operations of each process, and the content thereof is not written in source code but is concisely described by using commands as will be described later. In this regard, a macro file refers to a text file in which commands to be executed are

listed, and is employed in general for the automation of a display process of a simple data structure.

Further, a command is an instructional statement defining an operation of each device. For example, a  
5 command is an operation portion of a corresponding device in source codes of sequential operations converted into hard codes, and is a portion taken out of the source codes of the sequential operations. For instance, a in a form of source codes form corresponding to the operation of turning on the  
10 electrostatic chuck (ESC) or the operation of turning on a supply of a high frequency current to the lower electrode while for each device, a predetermined operation is defined as a command.

In addition, corresponding to the loading preparation  
15 process, a Pre-Wafer (PW) macro file is set up, and for the loading process, a loading (TI) macro file is set up. Further, corresponding to the preparation process, a Pre-Process (PR) macro file is set up, and corresponding to the first stabilization process, the first maintenance process,  
20 the second stabilization process, the second maintenance process and the end point process, step (SP1 to SP5) macro files are set up, respectively. Further, corresponding to the first post process, a wafer vacuum evacuation (T1) macro file is set up, and corresponding to the second post process,  
25 a chuck OFF (T2) macro file is set up. Moreover, corresponding to the after-treatment process, an after-



treatment (PO) macro file is set up, and corresponding to the unloading process and the static electricity removal process, an unloading macro (TO) file, and an After-Wafer-Process (AP) macro file are set up, respectively.

5           Fig. 3 illustrates a part of a process sequence macro for use in the substrate processing system shown in Fig. 1.

As shown in Fig. 3, multiple commands expressed in the form of, e.g., 「<Command Name = "A" Category = "B" Target = "C" Type = "D"/>」 are arranged in the TI macro file which is  
10 a part of the process sequence macro. In this command example, 「Name」 defines the name of a command; 「Target」 designates a device to be controlled; 「Category」 specifies the operation of a device designated by 「Target」; and 「Type」 defines properties of the content of processing to  
15 be performed by the corresponding command. For example, 「<Command Name = "HeGasVacuumStart" Category = "PREPROCESSVACUUM" Target = "HeGas" Target = "Device"/>」 is a command for performing an operation named 「HeGasVacuumStart」, wherein the operation draws in He gas  
20 serving as a processing gas from the inside of a substrate processing apparatus.

A subordinate command 「<Follow Name = "E"/>」 designates an execution timing of a dominant command. For example, 「<Follow Name = "HeGasVacuumStart">」 indicates an  
25 execution of a dominant command after the completion of the command named 「HeGasVacuumStart」.

Further, another subordinate command 「<Argument Name =  
"F" Type = "G">/」 sets a parameter of an operation content  
of a device designated by the dominant command. For  
instance, 「<Argument Name = "Wafer backside pumping time  
5 before pressure control" Type = "ChamberParameter">/」  
indicates that the name of a parameter is identified as  
「Wafer backside pumping time before pressure control」 and  
the content thereof is set by using 「ChamberParameter」.  
Here, a recipe can also be set up in addition to the  
10 parameter.

Further, the TI macro file in Fig. 3 regulates a  
sequential operation of the loading process by using  
multiple commands. Accordingly, by modifying commands in  
the macro file, changes in sequential operations can be  
15 easily made.

Further, as described above, since a macro file is set  
up for each of the processes divided from the etching  
processing of the semiconductor wafer W, the etching  
processing of the semiconductor wafer W can be carried out  
20 by performing a block of macro files (macro) combined in the  
order of PW macro file, TI macro file, PR macro file, Step  
macro files, T1 macro file, T2 macro file, PO macro file, TO  
macro file and AP macro file. At this time, the combined  
macro becomes a process sequence macro.

25 Referring back to Fig. 1, in the substrate processing  
system 100, the server 103 stores therein multiple commands

in advance, and the server communication unit 109 sends commands designated by a user from the server 103 to the RAM 105 when creating a macro file or changing the content of a macro file. Further, in the RAM 105 of the macro file editor unit 107, a macro file in which multiple commands are arranged is generated for each step of the etching process of the semiconductor wafer W in accordance with the user's instruction inputted via the user interface 106.

Further, with respect to the RAM 105, macro files containing multiple commands are generated and the generated macro files are also integrated so that a process sequence macro as an upper-level macro file is generated. The process sequence macro corresponds to a list of operation menus displayed on touch panels 621 and 631, which will be described later with reference to Fig. 6, via the user interface 106, and is executed when the user selects an operation menu on the touch panels by selecting it with fingers. By hierarchizing macro files as described, a single stable interface can be provided, and, further, the interface allows operators to access various properties of lower-layer command. Further, by integrating multiple macro files, the overall size of macro files become smaller while batch-processing of multiple macro files representing different sequential operations is enabled.

The executor 108 executes the created process sequence macro to control the operation of each device of the

substrate processing apparatus 101, thereby performing the etching process on the semiconductor wafer W. Further, the process sequence macro can be stored in the server 103 or the like.

5           The user interface 106 displays on its monitor multiple selectable processes of the etching processing, and, if a certain process is chosen, it shows selectable commands available for carrying out the selected process or existing macro files, that are already stored in the server 103,  
10           corresponding to the selected process. In addition, the user creates a macro file by selecting displayed processes and commands, or selects an existing macro file to change its content, thereby changing the content of the sequential operation.

15           After a macro file is generated or the content of a macro file is changed in the RAM 105, the server communication unit 109 sends a corresponding macro file to the server 103. Further, when creating a macro file or changing the content of a macro file, the server  
20           communication unit 109 also transmits the macro file stored in the server 105 to the RAM 105.

          Further, the PC communication unit 110, when creating a macro file or changing the content of a macro file, sends commands or macro files present in the RAM 105 to the PC 104,  
25           and also transmits macro files existing in the PC 104 to the RAM 105.

Further, the executor (verification unit) 108, when a macro file is sent to the RAM 105 by the server communication unit 109 or the PC communication unit 110, or when a macro file is created or the content of a macro file is changed in the RAM 105, examines whether or not the corresponding macro file is executable by the executor 108.

Hereinafter, a processing of a substrate by using the substrate processing apparatus shown in Fig. 1 is explained.

Fig. 4 shows a flowchart depicting a substrate processing performed by the substrate processing system in Fig. 1.

In Fig. 4, the user interface 106 displays on its monitor multiple selectable processes of an etching processing (Step S401), and the user selects a process to which content changes of a sequence is to be directed (Step S402).

Subsequently, the user interface 106 displays options as to whether or not to create a new macro file, and then determines whether the user has selected an option to create a new macro file (Step S403).

If it is found in the step S403 that the user has selected the option requesting the generation of a new macro file (YES in the step S403), the user interface 106 displays commands available to carry out the selected process on the monitor (Step S404). Then, the user selects desired commands and arranges the selected commands, thereby

generating a macro file (Step S405). At this time, the user determines, for each of the selected commands, a name, a device to be controlled, an operation of the device, a property of a processing content and, if necessary, a subordinate command is also decided. Further, the server communication unit 109 sends the commands selected by the user to the RAM 105 from the server 103 in which the commands converted into hard codes are stored.

If it is found in the step S403 that the user has selected an option to refuse the creation of a new macro file (No in the step S403), the user interface 106 displays existing selectable macro files which are stored in the server 103 and corresponding to the selected process (Step S406). Then, the user selects a desired one from the displayed macro files (Step S407), and by editing commands in the selected macro file, the content of the macro file is modified (Step S408). At this time also, the server communication unit 109 sends the commands designated by the user to the RAM 105 from the server 103.

Subsequently, the server communication unit 109 transmits to the server 103 the new macro file obtained in the step S405 or the macro file whose content is changed in the step S408 (Step S409). Concurrently, the user interface 106 provides options as to whether or not to continue the change in the content of a sequence, and determines whether the user selected an option requesting the continuation of

the change of the sequence content (Step S410).

If the user requests in the step S410 the continuation (YES in the step S410), the step 401 is repeated, otherwise, if the user refuses to continue the content change (NO in  
5 the step S410), the executor 108 determines the executability of all macro files in the RAM 105 (Step S411).

If any inexecutable macro file is found in the step S411 (No in the step S411), the executor 108 displays the inexecutable macro file on the monitor of the user interface  
10 106 (Step S412), and the process is terminated.

If all the macro files are determined to be executable in the step S411 (YES in the step S411), a process sequence macro is created by combining the macro files in accordance with a corresponding process sequence (Step S413). Then,  
15 the executor 108 executes the created process sequence macro to control the operation of each device in the substrate processing apparatus 101, thereby performing an etching process on the semiconductor wafer W (Step S414). Thereafter, the process is completed.

20 Next, an interlock processing of the substrate processing apparatus 101, performed by the executor 108, is explained. The term 'interlock' herein refers to a control, by controlling operations among processes, performed in a manner that another device is operated only when one device  
25 is in a proper state.

A data file, in which a control of a certain operation

of a device corresponding to a predetermined macro file (hereinafter referred to as a "interlock") is defined, is not in a form of source code but is concisely described by using IDs (identifiers) in a predetermined data format, e.g., EXCEL and stored in the server 103. An ID, as an instructional or conditional statement for defining an interlock of each device, is a portion corresponding to the control of a certain operation of a corresponding device in, e.g., source codes of sequential operations converted into hard codes, and, like the commands as described, is taken out of the source codes of the sequential operations. Based on such data file, an interlock for a specific operation of each device in the substrate processing apparatus 101 is defined.

Also defined in such a data file by using IDs are an alarm operation for reporting the execution of an interlock of a corresponding device (hereinafter referred to as an "alarm"); and a control of another device related to the interlock of the corresponding device (hereinafter referred to as a "recovery processing").

The data file is described for each of multiple devices corresponding to the specific macro file and, further, is also described for each of multiple operations of a predetermined device among the multiple devices. Based on the data file, an interlock as an interlock processing of a specific operation of each device of the substrate



processing apparatus 101, an alarming operation and a recovery processing are defined.

In the substrate processing system 100, the sever 103 contains multiple data files stored in advance, and the  
5 server communication unit 109, when creating a data file or changing the content of a data file, sends the data file designated by the user to the RAM 105 from the server 103. Further, in the RAM 105, a data file for each of devices in the above-described macro file is written in accordance with  
10 instructions of the user inputted via the user interface 106.

The user interface 106 displays a data file corresponding to a predetermined device designated by the user. The user can change the content of a sequence by editing IDs in the data file displayed on the user interface  
15 106.

The macro file editor unit 107 generates a data file by using the RAM 105 and the user interface 106, and the executor 108 executes the data file created by the macro file editor unit 107 so that the interlock processing of the  
20 substrate processing apparatus 101 is carried out.

Fig. 5 schematically shows an example of a data file stored in the server 103. Hereinafter, an interlock processing on an operation of an exhaust valve (hereinafter refer to as a "BPC OUT valve (G82)"), which is installed in  
25 the substrate processing apparatus 101 to evacuate a He gas used as a processing gas from the interior of the substrate

processing apparatus 101, is described.

In Fig. 5, the leftmost column of an Excel sheet as a data file, i.e., 「Abstract Table」 defines an operation of a device and an ID 「NMS\_ILT\_BPC\_OUT\_VLV2」 represents an operation of opening the BPC OUT valve (G82). The next column 「Check Item」 describes conditions that need to be satisfied in order to execute such operation of the device, i.e., interlock, wherein an ID 「BPC OUT valve (G82) open interlock, the presence of wafer + ESC HV OFF, NMF\_ILF\_ESC\_HV\_OFF\_WAHER, the presence of wafer + ESC VOLTAGE ZERO, MNS\_ILF\_ESC\_VOLT\_ZERO\_WAHER」 specifies conditions that a semiconductor wafer W is placed on a lower electrode while a high frequency power supply is turned off; or the semiconductor wafer W is placed on the lower electrode while a current generated by a voltage applied from the high frequency power supply is 0.

Next, the column 「Factor List」 describes an interlock, i.e., a recovery processing, related to the ID inputted in the above-described 「Check List」. For example, it includes IDs describing a condition required for placing the semiconductor wafer W on the lower electrode or for regulating the high frequency power supply off. Here, it is assumed that the ID of the interlock related to the check list is not inputted for the simplicity of explanation.

Further, 「Error Code 1」 to 「Error Code 4」 describe an alarm operation warning that the operation of the certain

device designated by the ID in the 「Abstract Table」 has not been performed. For example, an ID 「NMS\_ERR\_BPC\_OUT\_VLV2」 defines an operation of notifying the fact that the BPC OUT valve (G82) is not opened. 「Error Code 2」 to 「Error Code 4」 represent IDs of texts to supplement the text of the 「Error Code 1」. As such, an alarm operation is carried out by converting a string of characters into an ID that is recognizable by the program.

The IDs in the Excel Sheet configured as described above are converted into a CSV file as a preservation format of the data file, and the CSV file is converted again into a parameter file. The executor 108 conducts the interlock processing concerning the operation of opening the BPC OUT valve (G82) by reading the parameter file.

In accordance with this embodiment, since commands for defining operations of devices are stored; macro files are generated for each of multiple processes of an etching processing from the stored commands while a process sequence macro in which the generated macro files are combined is created; and the process sequence macro in which the macro files are combined according to a process order is performed, it becomes possible for the user: to change the content of a sequence by changing the content of the macro files through the use of the commands without a need to rewrite source codes; and, to change the content of a process sequence frequently without requiring a great number of works that

should be accomplished by the user. Especially, the convenience of user is improved since the user can readily change the content of the sequence just by acquiring the technique of writing the macro files.

5           Since the macro file editor unit 107 includes the user interface 106 in the above-described substrate processing system 100, the user can change the content of the macro files readily and further, since a command is in a form of source codes of a sequential operation that is converted  
10       into hard codes, a compiling or linking step is not needed when the executor 108 performs the process sequence macro, thereby greatly reducing the number of works that should be performed by the user.

          Further, since the macro files generated by the macro  
15       file editor unit 107 are stored in the server 103 in the above-described substrate processing system 100, the user can recycle already generated macro files when changing the content of a sequence, so that the number of works of the user can be greatly reduced.

20           Moreover, in the aforementioned substrate processing system 100, since all macro files, existing in the RAM 105, including those received from the PC 104 are subjected to a verification (determination) process for examining whether they are executable, a process error can be prevented from  
25       occurring when performing a process sequence macro containing macro files, thereby improving operation

efficiency.

Further, in accordance with this embodiment, since the server 103 stores therein a data file defining device interlocks corresponding to a macro file; the macro file editor unit 107 creates the data file; and the executor 108 executes an interlock of a device based on the created data file, the user is enabled to change a sequence with respect to the interlock by using the data file written in a predetermined data format without a need to rewrite source codes. Particularly, when evaluating a new device or examining an inappropriateness of the device's application to the substrate processing apparatus 101, if the user learns how to write data files, frequent changes in the content of the interlock becomes possible.

Further, in accordance with this embodiment, since a data file also defines an alarm, which reports a completion of a device's interlock and defines a recovery processing related to the interlock of the corresponding device, the user can change the content of the alarm to notify the completion of the interlock of the device and the recovery processing concerning the interlock of the corresponding device without rewriting source codes. As a result, the user can readily identify which alarm is generated when a particular interlock of a device is performed even without reading the source codes.

A substrate processing system in accordance with a

second embodiment of the present invention will now be described.

Referring to Fig. 6, there is described a schematic configuration of a substrate processing system in accordance  
5 with the second embodiment.

In Fig. 6, a substrate processing system 600 includes a plasma processing apparatus 610 for performing an etching process on a semiconductor wafer W; a controller 620 disposed adjacent to the plasma processing apparatus 610,  
10 for controlling the plasma processing apparatus 610; a remote terminal 630 placed by isolating it from the plasma processing apparatus 610, for remote-controlling the plasma processing apparatus 610 via the controller 620; and a LAN (Local Area Network) 640 such as Ethernet (a registered  
15 trademark) for connecting the controller 620 and the remote terminal 630.

The controller 620 includes a touch panel (operation input unit) 621 by which the user inputs a desired operation; an HDD (Hard Disk Drive) 622 serving as a storage  
20 unit for storing recipes for use in the etching processing and control parameters (target values of temperature, pressure, kinds of gases and their flow rates, time and the like); and equipment software 623 for controlling the etching processing. The equipment software 623 has an user  
25 interface 624 for controlling the operation of the touch panel 621; an input determination unit 625 (Facade) (input

control unit, input source determination unit) for determining an input source of the operation designated by the user, which will be described later; and an equipment controller 626 for controlling multiple devices constituting the plasma processing apparatus 610 based on the recipes and the control parameters read from the HDD 622 or an operation item selected by the user, which will be also described later. The user interface 624 is connected to the touch panel 621 and the input determination unit 625, which is in turn coupled to the remote user interface 632 via the LAN 640. Further, the equipment controller 626 is connected to the input determination unit 625, the HDD 622 and the plasma processing apparatus 610.

The user interface 624 displays an operation menu list containing multiple operation items on the touch panel 621. If the user selects a desired operation item from the displayed operation menu list by touching it, for example, with fingers, the user interface 624 sends the selected operation item to the equipment controller 626 via the input determination unit 625.

Here, the operation items displayed on the touch panel 621 relate to, e.g., a selection and a content edition of recipes and control parameters employed for the etching process or a release of a stoppage (alarm) of the plasma processing apparatus 610 caused by a minor trouble, and the like.

The remote terminal 630 includes a touch panel (another operation input unit) 631 by which the user inputs a desired operation; and a remote user interface (another software) 632 for controlling the operation of the touch panel 631. The remote user interface 632 displays an operation menu list containing multiple operation items on the touch panel 631. If the user selects a desired operation item from the displayed operation menu list by touching it with, e.g., fingers, the remote user interface 632 sends the touched operation item as the operation item selected by the user to the equipment controller 626 via the LAN 640 and the input determination unit 625. Further, the remote terminal 630 can be substituted by a personal computer available on the market.

When the operation item selected by the user is received and if it requires the user to observe the plasma processing apparatus 610 directly, the input determination unit 625 determines the sender of the operation item among the user interface 624 and the remote user interface 632. If it is determined that the corresponding operation item is transmitted from the remote user interface 632, the received operation item is not sent to the equipment controller 626. If it is found to be sent from the user interface 624, however, the received operation item is transferred to the equipment controller 626.

Here, the operation item requiring the user's



firsthand observation of the plasma processing apparatus 610 refers to, e.g., a release of a stoppage of the plasma processing apparatus 610 caused by a serious trouble, a selection of a recipe for a transfer process of the semiconductor wafer W conducted in the atmosphere or content editing thereof.

Further, in a certain condition where, for example, another user is editing the recipe by using either one of the touch panels 621 and 631, the input determination unit 625 prevents the user from editing the corresponding recipe at the other touch panel.

Here, the remote user interface 632 and the user interface 624 are developed by using a same development tool and have same contents. That is, source codes of each of the remote user interface 632 and the user interface 624 are described by using, e.g., JAVA (registered trade mark), and their contents are same as well. At this time, each of the controller 620 and the remote terminal 630 needs to be equipped with an interpreter (for example, JAVA (registered trade mark) Virtual Machine). Moreover, though an OS (Operation System) in which the user interface 624 and the remote user interface 632 are operated is not limited to any specific one if the source codes of the two are described in JAVA, it is preferable to use a general-purpose OS such as Windows (a registered trademark).

As described, since the user interface 624 and the

remote user interface 632 are developed by using a same development tool and have the same contents, the operation menu lists displayed on display panels of the touch panels 631 and 621 are also identical.

5       Next, a process for controlling the plasma processing apparatus 610 by using the controller 620 in Fig. 6 is described.

10       Fig. 7 is a flow chart describing a control process of the plasma processing apparatus 610 executed by the controller 620 in Fig. 6.

15       Referring to Fig. 7, if a user turns on the operation startup switch (not shown) of a plasma processing apparatus provided at the controller 620 or the remote terminal 630, the user interface 624 and the remote user interface 632 display an operation menu list on the touch panels 621 and 631 (Step S201).

20       If the user selects a desired operation item by touching it with a finger on the touch panel 621 or the touch panel 631, the user interface 624 or the remote user interface 632 sends the selected operation item to the input determination unit 625 (Step S202).

      Then, the input determination unit 625 determines whether the received operation item has been transmitted from the remote user interface 632 (Step S203).

25       If it is found in the step S203 that the operation item has been received from the remote user interface 632

(YES in the step S203), the input determination unit 625 then decides whether the operation item requires the user to observe the plasma processing apparatus 610 on the spot (Step S204).

5           If the operation item is found in the step S204 to demand a firsthand observation of the user (YES in the step S204), the process is terminated. If the operation item is found not to require the firsthand observation in the step S204 (NO in the step S204), however, the input determination  
10       unit 625 checks whether another user is controlling the plasma processing apparatus 610 by using the touch panel 621 when the operation item is received (Step S205).

          If it is determined in the step S205 that another user is currently controlling the plasma processing apparatus 610  
15       (YES in the step S205), the input determination unit 625 notifies the remote user interface 632 that the received operation item is not executable, and the remote user interface 632 reports the inexecutability of the plasma processing apparatus 610 on the touch panel 631 (Step S206).  
20       Then, the process is terminated.

          Referring back to the step S203, if it is found that the operation item is not transmitted from the remote user interface 632 (NO in the step S203), the input determination unit 625 decides whether another user is controlling the  
25       plasma processing apparatus 610 by using the touch panel 631 when the operation item is received (Step S207).

If it is noticed in the step S207 that another is controlling the plasma processing apparatus 610 (YES in the step S207), the input determination unit 625 reports the user interface 624 that the received operation item cannot  
5 be executed, and the user interface 632 then reflects the inexecutability of the desired operation of the plasma processing apparatus 610 on the touch panel 621 (Step S208). Then, the process is terminated.

If the determination in the step S205 or S207 reveals,  
10 however, that there is no other user who is controlling the plasma processing apparatus 610 (NO in the step S205 or NO in the step S207), the input determination unit 625 sends the received operation item to the equipment controller 626 (Step S209), and the equipment controller 626 then operates  
15 multiple devices constituting the plasma processing apparatus 610 based on the received operation item (Step S210). Then, the process is terminated.

In accordance with the embodiment described above, the user interface 624 controls the operation of the touch panel  
20 621, and the remote user interface 632, whose source codes have the same contents as those of the user interface 624, controls the operation of the touch panel 631. As a result, control of the touch panels 621 and 631 can be accomplished by using the same software, and the number of works that  
25 should be done by the soft engineer can be reduced. Furthermore, the number of processes required for creation

of software for controlling operations of the plasma processing apparatus 610 and the remote controller 630, and, further, the number of works for managing them can also be reduced.

5           In the above-described substrate processing apparatus 600, the input determination unit 625 restricts an operation input from either one of the touch panels 621 and 631. Therefore, in controlling the plasma processing apparatus 610, e.g., in editing a recipe of the substrate processing  
10 (process), duplicative operation inputs from the touch panels 621 and 631 can be avoided, thereby enabling a smooth control of the plasma processing apparatus 610.

Moreover, since the input determination unit 625 determines an input source of an operation item inputted by  
15 the user, it can prevent an operation requiring direct observation of the user from being inputted via the touch panel 631, whereby the safety of the substrate processing can be improved.

Further, since the input determination unit 625 and  
20 the remote user interface 632 are connected to each other via the LAN 640, the controller 620 and the remote terminal 630 can communicate through a general-purpose protocol, e.g., TCP/IP, which helps an efficient build-up of the substrate processing system 600.

25           Further, since the OS in which the remote user interface 632 is operated is of a general-purpose, costs of

the remote terminal 630 can be reduced while improving the convenience of user in inputting operations, and the user of the remote terminal 630 need not invest in new equipment.

Moreover, since the operation menu lists displayed on  
5 the touch panels 621 and 631 are identical, the user can input a desired operation through the use of any one of the touch panels.

In addition, if one of the user interface 624 and the remote user interface 632 is upgraded, they may be  
10 programmed such that the upgraded one sends the fact that it is upgraded to the other, whereby the number of processes required to manage the software for use in controlling the plasma processing apparatus 610 and the remote terminal 630 can be further reduced.

15 Next, a substrate processing system in accordance with a third embodiment of the present invention will be explained in detail.

Referring to Fig. 8, a schematic configuration of a substrate processing system in accordance with the third  
20 embodiment of the present invention is described. The basic configuration and functions of the substrate processing system of the third embodiment closely resemble those of the substrate processing system provided in the second embodiment. Therefore, description of like parts and  
25 functions will be omitted; and instead distinctive parts and functions will be focused on and elaborated.

In Fig. 8, the substrate processing system 300 includes a plasma processing apparatus 610; a controller 620; a remote terminal 630; and a LAN 640, wherein the controller 620 has device software 320 instead of the equipment software 623. The device software 320 has an user interface 321 for controlling the operation of a touch panel 621; an input determination unit (Facade) 322 for determining an input source of an operation designated by the user, which will be described later in detail; an equipment controller 626 for controlling multiple devices constituting the plasma processing apparatus 610 based on operation items selected by the user, which will be also described later; and a remote display 323 serving to recognize an operation input from a touch panel 330 as an operation input from the touch panel 621, which will be also described later. The user interface 321 is connected to the touch panel 621, the input determination unit 322 and the remote display 323, wherein the remote display 323 is in turn coupled to the touch panel 330 via the LAN 640. Further, the equipment controller 626 is connected to the input determination unit 322, an HDD 622 and the plasma processing apparatus 610.

The user interface 321 displays an operation menu list containing multiple operation items on the touch panel 621. If the user selects a desired operation item from the displayed operation menu list by, for example, touching it,

the user interface 321 sends the touched operation item as the operation item selected by the user to the equipment controller 626 via the input determination unit 322. Here, the operation menu list displayed on the touch panel 621 by  
5 the user interface 321 is identical to that displayed by the user interface 624.

Further, the remote terminal 630 incorporates the touch panel 330 through which the user inputs a desired operation. The remote terminal 630 can be replaced by a  
10 personal computer available on the market.

The remote display 323 is software capable of executing a VNC (Virtual Network Computing), and serves to recognize a predetermined region (not shown) on the touch panel 330 as the touch panel 621; shows on the predetermined  
15 region of the touch panel 330 the same contents that are displayed on the touch panel 621 by the user interface 321; and identifies an input to the predetermined region as an input to the touch panel 621.

Therefore, the remote display 323 displays on the  
20 aforementioned predetermined region the operation menu list displayed on the touch panel 621, and, if the user selects a desired operation item from the operation menu list displayed on the predetermined region by touching it, it sends the touched operation item as the operation item  
25 selected by the user to the user interface 321. At this time, the user interface 321 transmits the received



operation item as the operation item selected by the user to the equipment controller 626 via the input determination unit 322.

When the operation item selected by the user is received, the input determination unit 322 decides whether the received operation item has been sent from the touch panel 621 or the predetermined region of the touch panel 330. In case the received operation item requires user's direct observation of the plasma processing apparatus 610, the input determination unit 322 does not send the received operation item to the equipment controller 626 when the operation item is found to be inputted from the predetermined region but sends the received operation item to the equipment controller 626 when the operation item has been inputted from the touch panel 621.

In a certain condition, e.g., where a user is editing a recipe via either one of the touch panel 621 and the predetermined region of the touch panel 330, the input determination unit 322 prohibits another user from editing the corresponding recipe via the other touch panel.

A control process of the plasma processing apparatus 610 performed by the controller 620 will now be described with reference to Fig. 8.

Fig. 9 is a flowchart explaining the process for controlling the plasma processing apparatus 610 by using the controller 620 in Fig. 8.

Referring to Fig. 9, if the user turns on an operation startup switch (not shown) of a plasma processing apparatus incorporated in the controller 620 or the remote terminal 630, the user interface 321 displays an operation menu list  
5 on the touch panel 621, and the remote display 323 shows the same operation menu list on the predetermined region of the touch panel 330 (Step S901).

Then, if the user selects a desired operation item by touching it on the touch panel 621, the user interface 321  
10 transmits the selected operation item to the input determination unit 322, whereas the remote display 323 sends the selected operation item to the user interface 321, and the user interface 321 transfers it to the input determination unit 322 if the user selects the desired  
15 operation item by touching it on a predetermined region of the display panel 330 (Step S902).

The input determination unit 322 determines whether the operation item is inputted from the touch panel 621 (Step S903).

20 If it is found in the step S903 that the operation item is not inputted from the touch panel 621 (NO in the Step S903), the input determination unit 322 then decides whether the operation item requires the user's direct observation of the plasma processing apparatus 610 (Step  
25 S904).

If the determination result in the step S904 reveals

that the operation item demands the firsthand observation of the user (YES in the step S904), the process is terminated. If the operation item does not require the user to observe directly in the step S904 (NO in the step S904), however,  
5 the input determination unit 322 checks whether another user is controlling the plasma processing apparatus 610 by using the touch panel 621 when the operation item is received (Step S905).

If it is determined in the step S905 that another user  
10 is currently controlling the plasma processing apparatus 610 (YES in the step S905), the input determination unit 322 informs the remote display 323 of the fact that the received operation item is not executable, and the remote display 323 then reports the inexecutability of the plasma processing  
15 apparatus 610 on the predetermined region (Step S906). Then, the process is terminated.

Referring back to the step S903, if the operation item is found to be transmitted from the touch panel 621 (YES in the step S903), the input determination unit 322 decides  
20 whether there exists another user who is controlling the plasma processing apparatus 610 via the predetermined region of the touch panel 330 when the operation item is received (Step S907).

If the determination result in the step S907 shows  
25 that there is another user who is currently using the plasma processing apparatus 610 (YES in the step S907), the input

determination unit 322 informs the user interface 321 that the received operation item cannot be executed, and the user interface 321 then reports the inexecutability of the desired operation of the plasma processing apparatus 610 on the touch panel 621 (Step S908). Then, the process is terminated.

If the step S905 or S907 finds, however, that there is no other user who is controlling the plasma processing apparatus 610 (NO in the step S905 or No in the step S907), the input determination unit 322 sends the received operation item to the equipment controller 626 (Step S909), and the equipment controller 626 operates a plurality of devices constituting the plasma processing apparatus 610 based on the received operation item (Step S910). Then, the process is terminated.

In accordance with the embodiment described above, the user interface 321 displays on the touch panel 330 operation items capable of being inputted to the touch panel 621, and the remote display 323 shows the operation items on the touch panel 621 and recognizes an input to the touch panel 330 as an input to the touch panel 621. Therefore, software for controlling the operation of the touch panel 330 is not required, so that the number of processes for creating and managing software for use in controlling the plasma processing apparatus 610 and the remote terminal 630 can be reduced.

Further, since the plasma processing apparatus 610 performs an etching process on a semiconductor wafer W in the substrate processing systems 600 and 300, the user can execute the etching process of the semiconductor wafer W by  
5 using the remote terminal 630.

Although the first embodiment has been described for the substrate processing system 100 where creation of macro files and changes of their contents are all performed in the RAM 105, the place for creating and changing the macro files  
10 is not limited to the RAM 105. For example, it is also possible that the PC communication unit 110 may send commands and macro files present in the RAM 105 to the PC 104 at a time of creating a macro file or changing the content of a macro file; then, the user generates a macro  
15 file or changes the content of a macro file in the PC 104 through the use of a keyboard or a mouse; and the PC communication unit 110 transmits the macro file created or changed in the PC 104 to the RAM 105. Through such process, the user can generate a macro file or change the content of  
20 a macro file by using the PC 104, so that the convenience of user can be improved. Further, the user can also performs a creation of a data file or a change in the content of a data file by using the PC 104.

Furthermore, in the substrate processing system 100,  
25 commands, macro files and process sequence macros are all stored in the server 103. However, the storage unit for

storing them is not limited to the server 103. For example, the commands are stored in the server 103 while the macro files and process sequence macros are stored in a separate external HDD and the like (another storage unit). Further, data files can be stored in a further separate external HDD and the like (still another storage unit). As a result, the risk of loss of data due to the system troubles can be lowered. For the purpose of simplifying the configuration of the substrate processing system 100, however, it is preferable to store all of the commands, macro files, process sequence macros and data files in the server 103.

In addition, a macro file may not be stored for each process by a one-to-one correspondence; that is, there can be stored multiple macro files corresponding to a single process. Accordingly, when changing the contents of existing macro files is required, the user can select from the stored multiple macro files a macro file which is the most similar to a desired sequential operation and change the content thereof, thereby improving the work efficiency of the user.

Furthermore, in the first embodiment, a macro file in which multiple commands are arranged is created for each of processes in an etching processing of a semiconductor wafer W, and, at the same time, a process sequence macro, conceptualized as an upper-level macro file, is generated by integrating the thus created macro files. However, the

present invention is not limited thereto. That is, a process sequence macro as an upper-level macro file can be created by generating a macro file first in which multiple commands are arranged and then sorting multiple macro files  
5 thus created according to a process sequence. By hierarchizing the macro files, a single stable interface can be provided, and, further, the interface allows operators to access various properties of lower-layer command. Moreover, by sorting the multiple macro files according to a process  
10 sequence, sorting and combining of the macro files can be easily performed.

Further, though the substrate processing apparatus 101 and the substrate processing controller 102 are described as separate elements in the substrate processing  
15 system 100, the substrate processing apparatus 101 and the substrate processing controller 102 need not be separated. For example, the substrate processing apparatus 101 may be configured to incorporate an element equivalent to the substrate processing controller 102.

20 Though it is preferable that a macro file created by the substrate processing system 100 has a format of XML for general purpose, the format is not limited thereto but can be in any format as long as it can be written through arrangements of commands.

25 Though data files created by the substrate processing system 100 are concisely described in an Excel format by

using IDs, the format is not limited thereto. That is, any data format that can be read by general PC software can be employed. In such a case, data files edited by an external computer or another substrate processing apparatus can be  
5 used in the apparatus, and, additionally, a specification of a fixed format, e.g., a specification describing an interlock of the substrate processing apparatus 101, can be easily generated by using the data files.

Moreover, though the input determination units 625 and  
10 322 in the substrate processing apparatuses 600 and 300 in accordance with the second and the third embodiment, respectively, restrict an operation input of the user based on the necessity for user's firsthand observation or presence of another user, the restriction can be based on  
15 operation skills of the user or the user's job level so that the security of the substrate processing system can be improved, and an accident that might be caused by a wrong operation by the user can be prevented.

Although the plasma processing apparatus 610 and the  
20 controller 620 are installed as separate elements in the substrate processing system 600 and the substrate processing system 300 described above, they can be integrated as one element, thereby obtaining a compact substrate processing system.

25 In addition, since a current situation of the plasma processing apparatus 610 can be displayed on an operation



panel of the remote terminal 630 on a real-time basis via the remote user interface 632 or the remote display 323, a troubleshooting of the plasma processing apparatus 610 can be accomplished by a user who is located at a place isolated  
5 from the plasma processing apparatus 610.

In the above-described substrate processing system 600 and the substrate processing system 300, an operation item is selected by touching an operation menu list displayed on an operation panel. However, the operation item can be  
10 selected differently, for example, by pointing of a pointing device such as a mouse or by inputting a name of a desired recipe or a name of a control parameter through the use of a keyboard. Moreover, it is also preferable to select the operation item by putting an electronic pen such as a stylus  
15 down on the operation panel.

Though a single remote terminal 630 is connected to a single controller 620 in the substrate processing systems 600 and 300 described above, there is no limit in the number of remote terminals 630 coupled with the controller 620.  
20 For example, multiple controllers 620 and multiple remote terminals 630 can be connected via a public network such as the Internet, whereby the user can control a number of plasma processing apparatuses 610 by using any one of the multiple remote terminals 630.

25 Further, although the above-described plasma processing apparatus 610 is an etching processing apparatus,

the present invention can be applied to any semiconductor manufacturing apparatuses, e.g., an exposure apparatus, a CVD apparatus, an etching apparatus, a CMP apparatus, a resist coating apparatus, a developing apparatus, an ashing apparatus, an inspecting apparatus, and so forth.

Moreover, the object of the present invention can also be achieved by allowing an operation unit (CPU, MPU, or the like) of the substrate processing system 100 or 600, or the substrate processing controller 102 or the controller 620 to execute program codes of software for use in realizing functions of the above-explained embodiments of the present invention. In such a case, the program codes themselves constitute the invention.

A floppy (registered trademark) disc, a hard disc, a magneto-optical disc, a CD-ROM, a CD-R, a CD-RW, a DVD-ROM, a DVD-RAM, a DVD-RW, a DVD+RW, a magnetic tape, a nonvolatile memory card, a ROM, and the like, can be used as a storage medium for supplying the program codes to the operation unit.

Furthermore, in addition to the method for realizing the functions of the embodiments by way of allowing the operation unit to execute the program codes, it is also possible to obtain the same functions by controlling, e.g., an OS (operating system) operating on a computer to partially or entirely perform actual processes based on an indication of the program codes.

Moreover, the server 103 and the PC 104 can be integrated or the PC 104 can be configured to further serve as the server 103.

Though the embodiments has been described for the case  
5 where an etching process is exemplified as a substrate processing conducted by the substrate processing system 100 and the substrate processing system 600, the substrate processing executed by the substrate processing system 100 and the substrate processing system 600 is not limited to  
10 the etching process but can be, e.g., a CVD process, an ashing process, an ion doping process, a sputtering process, and the like.

[Brief Description of the Drawings]

Fig. 1 shows a schematic diagram of a substrate  
15 processing system in accordance with a first embodiment of the present invention;

Fig. 2 shows an example of dividing the substrate etching process with respect to the substrate processing system as shown in Fig. 1 into multiple sub-processes;

20 Fig. 3 shows a part of a process sequence macro in the substrate processing system of Fig. 1;

Fig. 4 is a flowchart depicting a substrate processing performed by the substrate processing system in Fig. 1;

Fig. 5 schematically shows an exemplary data file  
25 stored in a server of Fig. 1;

Fig. 6 illustrates a schematic diagram of a substrate

processing system in accordance with a second embodiment of the present invention;

Fig. 7 is a flow chart explaining a control process of a plasma processing apparatus performed by the controller  
5 shown in Fig. 6;

Fig. 8 illustrates a schematic diagram of a substrate processing system in accordance with a third embodiment of the present invention;

Fig. 9 shows a flow chart describing a control process  
10 of a plasma processing apparatus performed by the controller shown in Fig. 8;

Fig. 10 shows a schematic diagram of a conventional substrate processing apparatus; and

Fig. 11 illustrates a schematic diagram of a  
15 conventional remote control system.

[Explanation of References]

- 100 substrate processing system
- 101 substrate processing apparatus
- 102 substrate processing controller
- 5 103 server
- 104 PC
- 106 user interface
- 107 macro file editor unit
- 108 executor
- 10 109 server communication unit
- 110 PC communication unit